3. Crop Water Requirements (CWR)

- Evapotranspiration process
- Determination of Reference evapotranspiration – ETo
- Duty-delta relationship
- Determination of crop evapotranspiration – ETc
- Irrigation Efficiencies
- Irrigation Scheduling

Evapotranspiration (ET)

- The process whereby water is lost on one hand from the soil surface by evaporation and on the other hand from the crop by transpiration.

- Evaporation: Liquid water is converted to water vapour (vaporization) and removed from the evaporating surface (vapour removal).

- Energy is required to change the state of the molecules of water from liquid to vapour. This energy is mainly from solar radiation and, to a lesser extent, from the ambient temperature of the air.

Evaporation…

- The driving force to remove water vapour from the evaporating surface is the **difference between the water vapour pressure** at the evaporating surface and that of the surrounding atmosphere.

- Solar radiation, air temperature, air humidity and wind speed are climatological parameters to be considered while assessing the evaporation process.

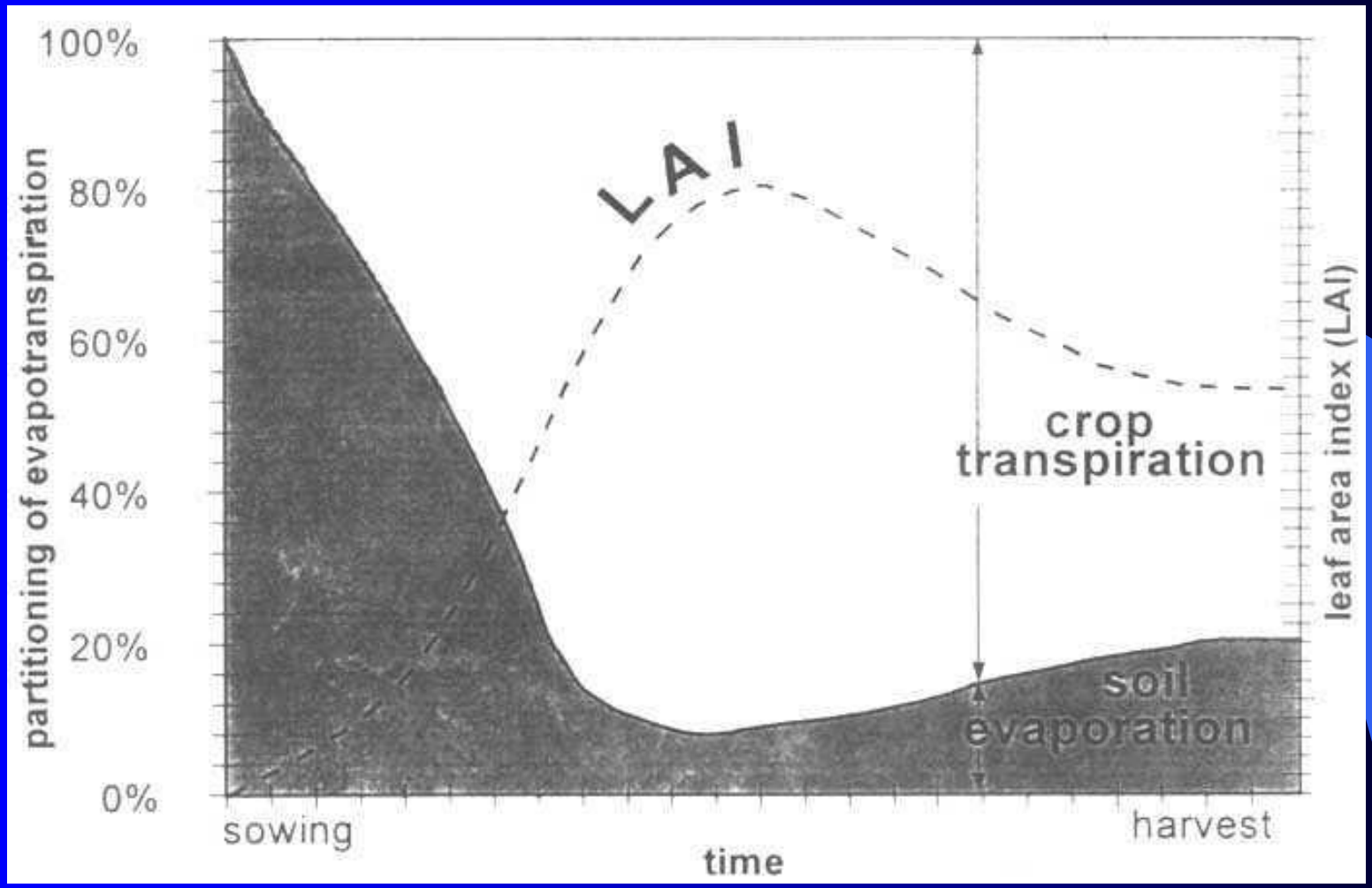
Transpiration

- Transpiration consists of the vaporization of liquid water contained in plant tissues and the vapour removal to the atmosphere.
- Crops predominately lose their water through stomata.
- Nearly all water taken up is lost by transpiration and only a tiny fraction is used within the plant.
- Transpiration, like direct evaporation, depends on the energy supply, vapour pressure gradient and wind.

Factors affecting transpiration process

- Radiation
- Air temperature
- Air humidity
- Wind speed
- Soil water content and the ability of the soil to conduct water to the roots
- Crop characteristics
- Environmental aspects and cultivation practices.

The partitioning of evapotranspiration into evaporation and transpiration over the growing period for an annual field crop



Evapotranspiration…

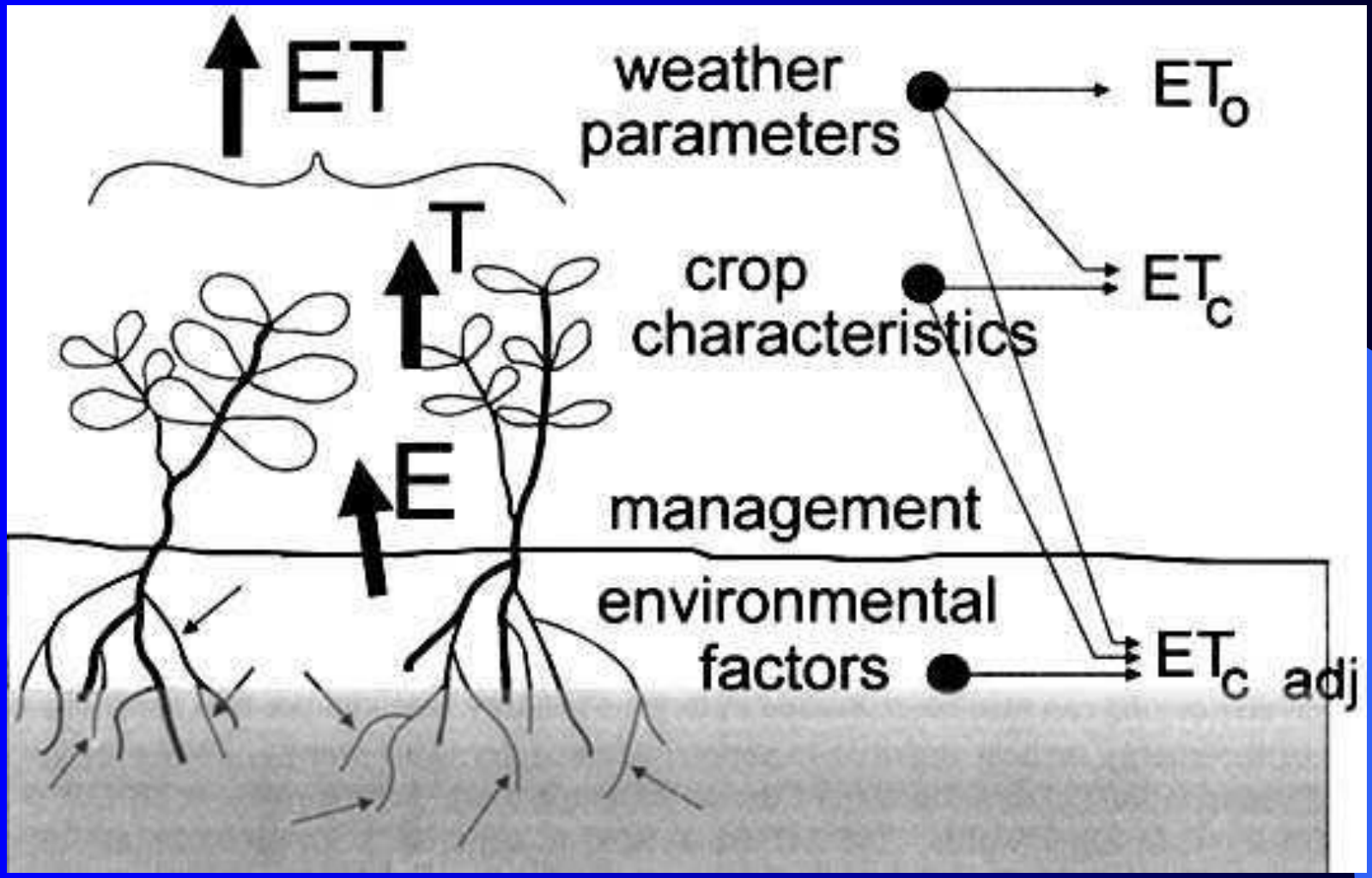
- Leaf area Index (LAI) = Leaf area/Soil area covered by leaf

- At sowing nearly 100% of ET comes from evaporation, while at full crop cover more than 90% of ET comes from transpiration.

Factors affecting ET

- - Climatic (weather) parameters (Ra , T, U, RH)
- Crop characteristics
  - Crop type & Variety
  - Growing length/development stages
- Management factors
- Environmental (soil) factors

Factors affecting ET



Reference Evapotranspiration - ETo

- is defined as ET from a hypothetical crop with an assumed height of 0.12 m having a surface resistance of 70 s/m and an albedo of 0.23, closely resembling the evaporation of an extension surface of green grass of uniform height, actively growing and adequately watered.

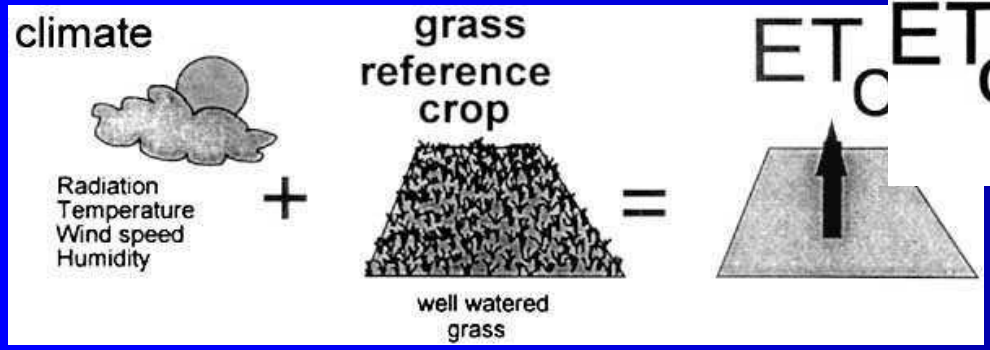
-Hypothetical crop
-extensive surface
-green grass
-uniform height (12 cm)
-actively growing
-adequately watered

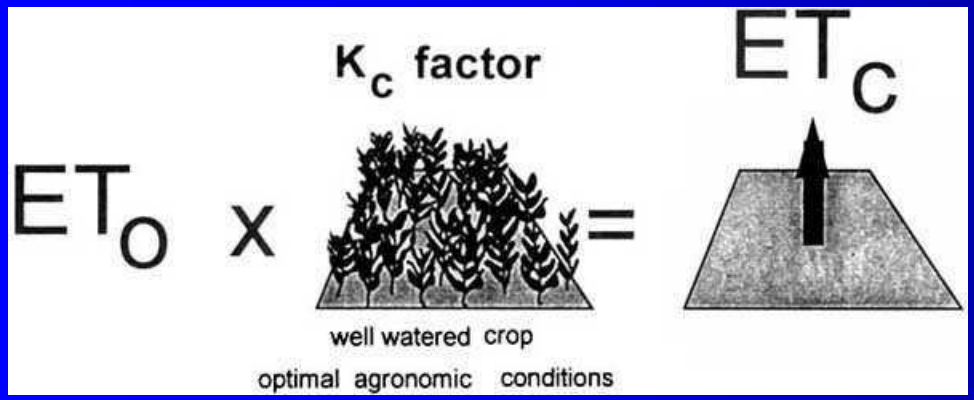
Crop Evapotranspiration under standard conditions - ETc

- refers to the evapotranspiration from excellently managed, large, well-watered fields that achieve full production under the given climatic conditions.

Crop Evapotranspiration under non-standard conditions – ETc-adj.

- Due to sub-optimal crop management and environmental constraints that affect crop growth and limit evapotranspiration, ETc under non-standard conditions generally requires a correction.





ETc = ETo * Kc

ETc –adj. = ETo * Ks*Kc

ET measurement

- Direct measurement appropaches

1- Lysimeter method

The crop grows in isolated tanks filled with either disturbed or undisturbed soil. In precision weighing lysimeters, where the water loss is directly measured by the change of mass, evapotranspiration can be obtained with an accuracy of a few hundredths of a millimeter, and small time periods such as an hour can be considered.

2. Field experimental plots

- Suitable for determination of seasonal water requirements.
- Water is added to selected field plots, yield obtained from different fields are plotted against the total amount of water used.
- The yield increases as the water used increases for some limit and then decreases with further increase in water.
- The break in the curve indicates the amount of consumptive use of water.

3. Soil moisture studies

- soil moisture measurements are done before and after each irrigation application.
- Knowing the time gap b/n the two consecutive irrigations, the quantity of water extracted per day can be computed by dividing the total moisture depletion b/n the two successive irrigations by the interval of irrigation.
- Then a curve is drawn by plotting the rate of use of water against the time from this curve, seasonal water use of crops is determined.

4. water Balance method

- Based on inflow – outflow – storage principle.

$ET = I + P - RO - DP + CR \pm \Delta SF \pm \Delta SW$

where: I - Irrigation

P – rainfall

RO - Runoff

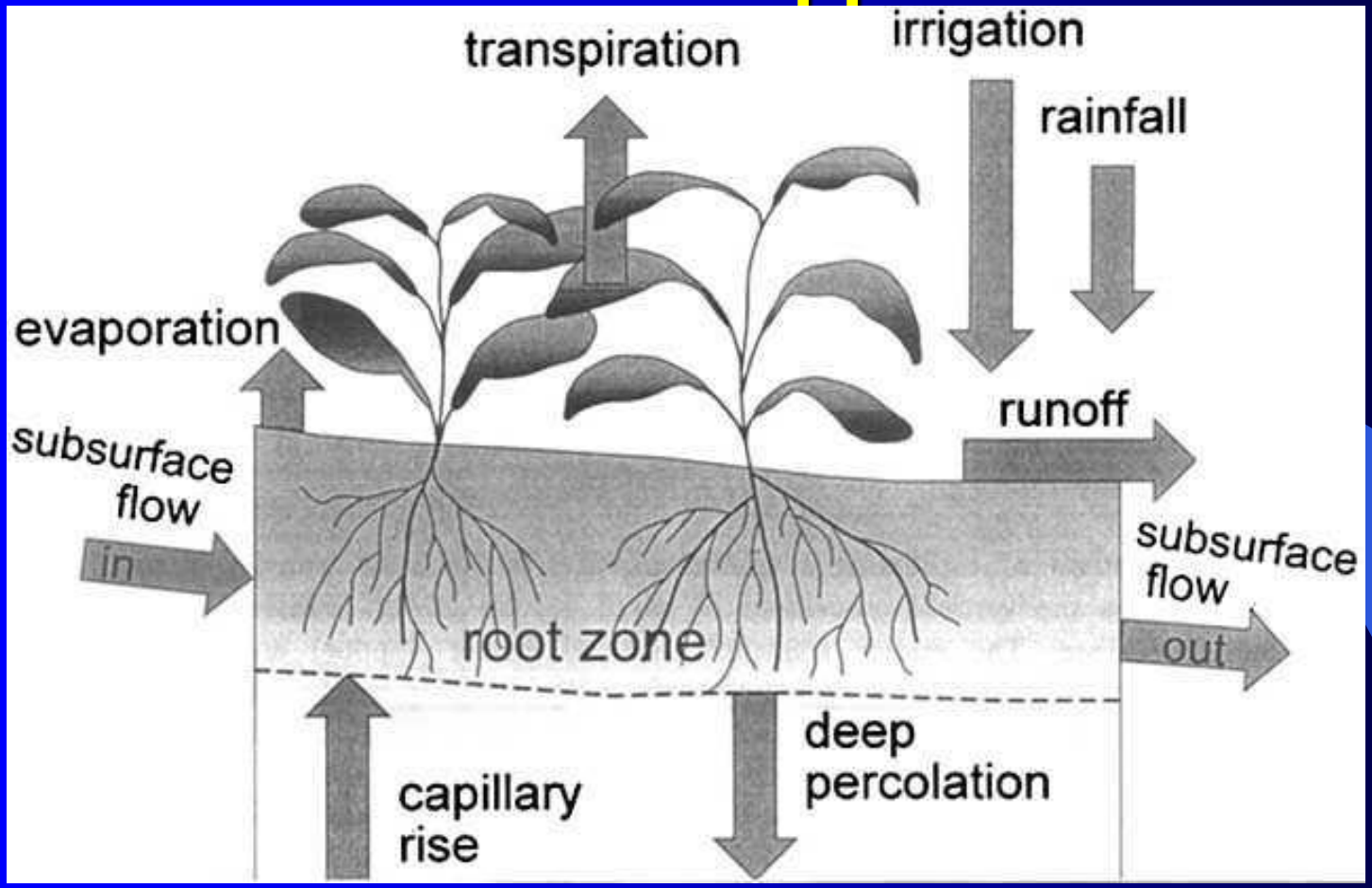
CR – capillary rise

DP – Deep percolation

SF – subsurface flow

SW – soil water content

Soil-water Balance approach



Climatic approaches of estimating ETo